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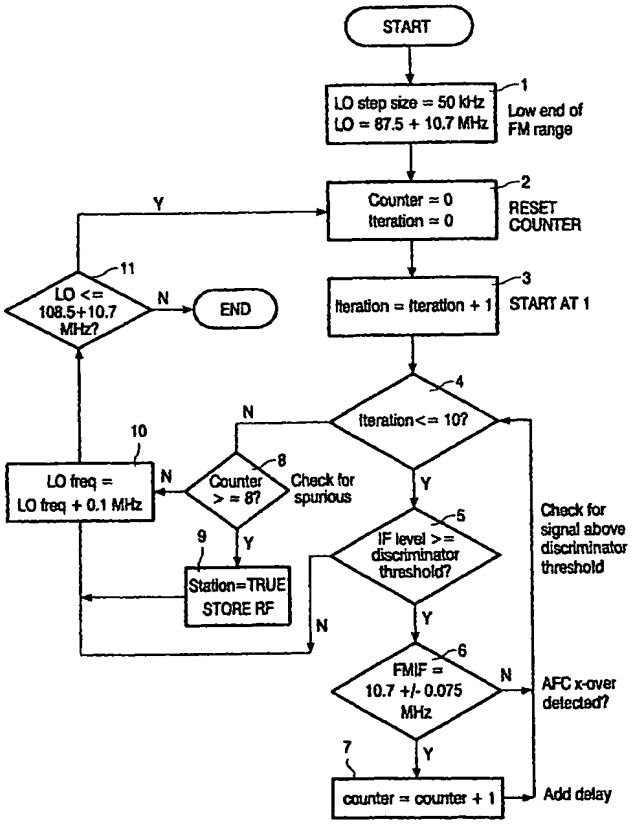
(54) Title: METHOD AND APPARATUS FOR AUTO-TUNING OF A RADIO FM-RECEIVER



(57) Abstract: In a method of auto-tuning a radio FM-receiver the receiver frequency band is scanned until a FM signal is received meeting criteria for identifying the signal as being of a predetermined quality, particularly coming from a valid FM station. At least during tuning it is permanently established whether or nor the FM signal meets the criteria, whereafter the results thereof are read a predetermined number of times, and the FM signal is only stored if at least most of these times the criteria are met. Particularly, the results are read 10 times and the FM signal is only stored if at least 8 times thereof the criteria are met.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND APPARATUS FOR AUTO-TUNING OF A RADIO FM-RECEIVER

The invention relates to a method of auto-tuning a radio FM-receiver by scanning the receiver frequency band until a FM signal is received meeting critera for identifying the signal as being of a predetermined quality, particularly coming from a valid FM station.

One of the essential features in a broadcast receiver is the auto-tune function. This enables a user to scan the receiver frequency band for available signals, tune them in and store them in presets, all at the press of a button. Particularly in TV-FM radio combi receivers TV and FM radio frequency signals are converted to baseband video and audio signals by means of such an auto-tune function. This auto-tune function is important, for example, for PC (personal computer) TV card makers who want to provide computer users with the possibility to enjoy broadcast TV and radio while working on their PC's.

The concept of auto-tuning for TV is well established and relatively error free, in that a TV signal is a unique type of modulated signal, which amongst other characteristics has a periodic synchronization pulse. With this it is always possible to discriminate between a TV signal and a non-TV signal, including short duration, non-periodic noise.

However, a relatively error free auto-tuning is not well possible in the case of FM radio. A FM discriminator is not inherently able to differentiate between a real FM radio signal and an interfering non-FM signal, which can be frequency stable or random. This results in a case where well known auto-tune systems may capture numerous signals and store them, but perhaps only a small part of them are intended signals. Tuning to the rest of the presets will give just irritating noise.

The first problem lies in the sensitivity of the receiver system, which is able to detect signals that are close to the noise floor. This means that the chance of mistakenly storing a random noise signal that exists at the moment of auto-tune is relatively high. In addition, it also means that a true FM signal that is very weak might also be captured. In reality once a FM radio signal falls below certain signal strength, commonly known as the FM threshold, it makes little sense to store a channel since the sound quality is simply too poor to be intelligible.

It is known to apply two conditions that need to be fulfilled when deciding if a signal is a valid FM station. The level of FM-IF signal must be sufficiently high. This can done, for example, by setting a bit in a status register, which is available to the user. This criterion is indicated in the following as "intensity". When this condition is met, the AFC (automatic frequency control) status must be checked; if the received signal is within the IF bandwidth, the second condition is met and the signal is then stored as a valid station. For the 10,7 MHz IF band, the received signals must be within ±75 kHz of the 10,7 MHz IF. This second criterion is indicated in the following as "AFC window" A concept of auto-tuning a radio FM-receiver by scanning the receiver frequency band until an FM signal is received meeting the above critera for identifying the signal of a predetermined quality, is already known, for example from the European patent application EP-A-0 430 469. When a received FM signal meets both critera, this is indicated in the following as "a positive check result".

However, in case that a sufficiently strong random interference reaches the demodulator of the radio FM-receiver, it too may be stored mistakenly as it can momentarily appear within the AFC window.

The purpose of the invention is to prevent capture of such frequency random interferences.

Therefore, according to the invention, the method as described in the opening paragraph is characterized in that at least during tuning it is permanently established whether or nor the FM signal meets the criteria, whereafter the results thereof are read a predetermined number of times, and the FM signal is only stored if at least most of the times the criteria are met. It has been found that good results are obtained when these results are read 10 times and the FM signal is only stored if at least 8 times thereof the criteria are met.

The invention further relates to an auto tuning device with means to register whether or not a FM signal, received in a radio FM receiver, meets criteria for identifying the signal as being of a predetermined quality, particularly coming from a valid FM station, and counting means to register in an interval of a predetermined number of times that is registered whether or not the FM signal meets the criteria, the number of times the FM signal meets the criteria. The invention also relates to a radio FM-receiver for realizing the above method, comprising the above auto-tuning device.

The invention further relates to an algorithm for processing FM signals in an auto tuning device according to the above, to a computer program capable of running on signal processing means in a radio FM receiver or cooperating with a radio FM receiver comprising the above auto tuning device, and to an information carrier, carrying instructions

to be executed by signal processing means, the instructions being such as to enable said processing means to perform the above method.

The invention will further be clarified by a specific embodiment and with reference to the drawing, showing a flow-diagram of the method according to the invention.

The scanning of the FM band, this is in most parts of the world the frequency range from 87,5 to 108,5 MHz, is performed by means of a local oscillator (LO) signal which is swept in a range from 98,2 to 119,2 MHz in steps of 50 kHz. In the flow-diagram this is indicated by block 1. At the beginning of each LO sweep a counter for counting positive check results is reset. As soon as a FM signal is received, it is checked whether or not this signal meets the signal quality criteria "intensity" and "AFC window". This is done in 10 iteration steps. When the counter is reset, the number of iterations is reset too. The iteration procedure is started by 1 (block 3), while each time the received FM signal is checked, the number of iterations is raised by 1. The number of iterations in this example is limited to 10. As long as the number of iterations has not reached the value of 10, indicated in block 4, it is checked whether or not the FM signal meets the criteria "intensity" (block 5) and "AFC window" (block 6). When the FM signal meets both criteria, the counter for positive check results is raised by 1 (block 7) and, after a short delay, a following check of the FM signal is performed (block 4). When, after 10 iteration steps (block 4), in this example 8 times a positive check has been registered (block 8), the found FM signal is coming from a real station and the corresponding radio frequency thereof is stored (block 9). When 10 iteration steps are performed and there are no 8 positive results (blocks 4 and 8), the LO frequency value is raised by two steps, this is by 100 kHz (block 10). When the end of the LO frequency sweep is not yet reached (block 11), the counter is reset again and a search to a valid FM station is started on a shifted frequency. When the end of the LO frequency sweep is reached, the procedure ends and can be started again. When the first criterion "intensity" is not met (block 5), the local oscillator signal is raised, whereafter the procedure is repeated or ended as described. When the first criterion "intensity" is met, but the second criterion "AFC window" not, the number of iteration steps is raised but, of course, not the number of positive results. Nevertheless, thereafter, a positive check result can be obtained, as it is still possible that 8 positive check results in 10 iteration steps are obtained.

This procedure is performed in an auto tuning device, being part of a radio FM receiver, with means to register whether or not a FM signal, received in a radio FM receiver, meets the criteria "intensity" and "AFC window". Whether or not the FM signal meets the

critera can permanently, or at least during tuning, be registered in the auto tuning device, for example in a status register therein. This status register will be read 10 times during each checking procedure. Therefore, the tuning device will comprise counting means to register in an interval of a predetermined number of times (10 times) that is registered whether or not the FM signal meets the criteria, the number of times the FM signal meets the criteria.

The above checking procedure will be performed by means of an algorithm in the form of a computer program capable of running on signal processing means in the radio FM receiver or cooperating with the radio FM receiver comprising the auto tuning device.

The invention is not restricted to the described embodiment. Modifications are possible. Particularly the number of iteration steps and the number of positive checking results within the number of iteration steps may be chosen differently from 10 and 8, respectively. Further, it can be noticed that the scanning procedure as described above can be applied for of a FM band in the frequency range from about 75 MHz to 91 Mhz, as is the case in Japan.

CLAIMS:

1. Method of auto-tuning a radio FM-receiver by scanning the receiver frequency band until a FM signal is received meeting critera for identifying the signal as being of a predetermined quality, particularly coming from a valid FM station, characterized in that at least during tuning it is permanently established whether or nor the FM signal meets the criteria, whereafter the results thereof are read a predetermined number of times, and the FM signal is only stored if at least most of the times the criteria are met.

2. Method as claimed in claim 1, characterized in that the results are read 10 times and the FM signal is only stored if at least 8 times thereof the criteria are met.

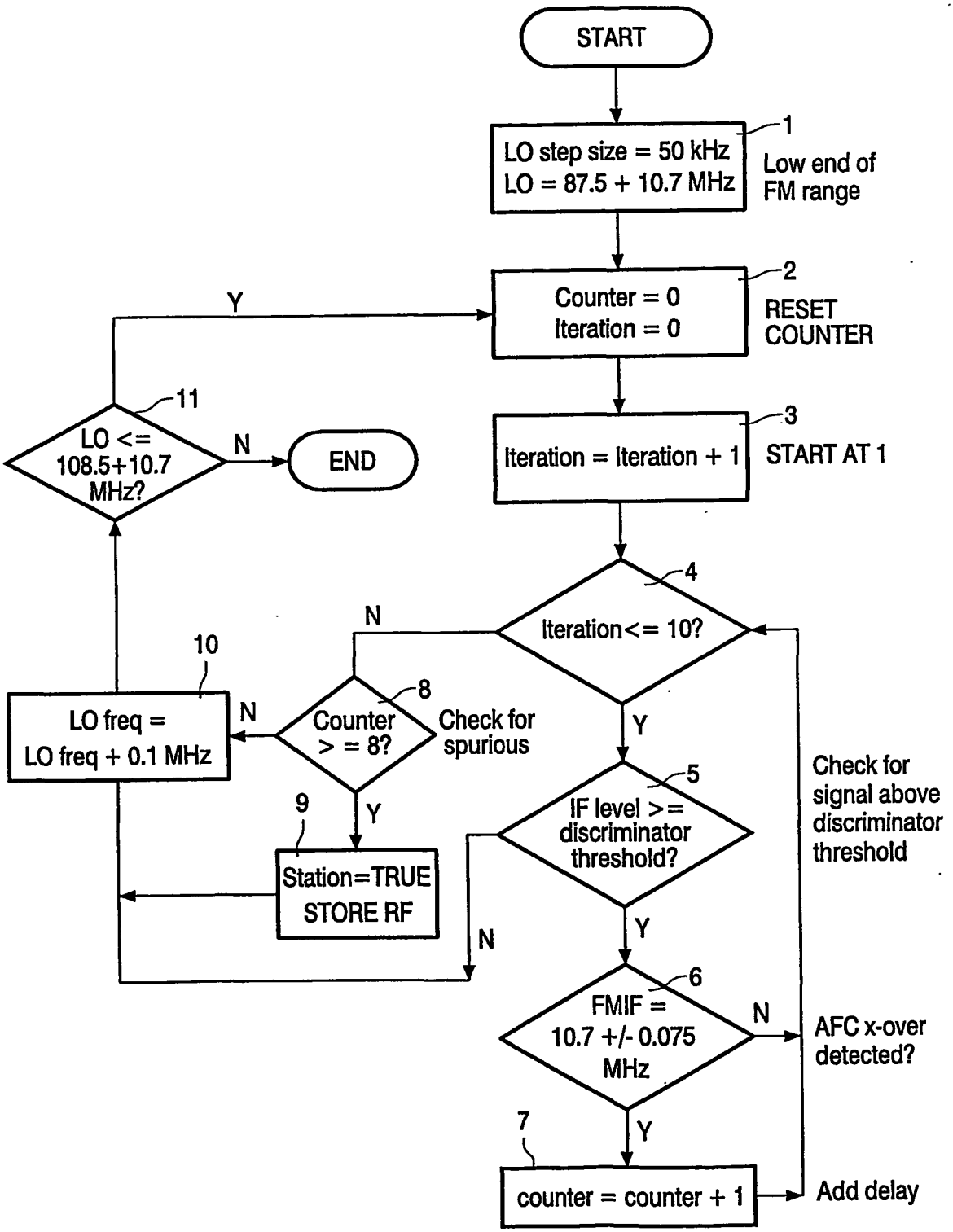
3. Auto tuning device with means to register whether or not a FM signal, received in a radio FM receiver, meets criteria for identifying the signal as being of a predetermined quality, particularly coming from a valid FM station, and counting means to register in an interval of a predetermined number of times that is registered whether or not the FM signal meets the criteria, the number of times the FM signal meets the criteria.

4. Radio FM-receiver for realizing the method of claim 1 or 2, comprising an auto-tuning device according to claim 3.

5. Algorithm for processing FM signals in an auto tuning device according to the method of claim 1 or 2.

6. Computer program capable of running on signal processing means in a radio FM receiver or cooperating with a radio FM receiver comprising the auto tuning device according to claim 3.

7. Information carrier, carrying instructions to be executed by signal processing means, the instructions being such as to enable said processing means to perform the method according to claim 1 or 2.


START
LO step size = 50 kHz
LO = 87.5 + 10.7 MHz
1
Low end of FM range
Counter = 0
Iteration = 0
2
RESET COUNTER
Y
Iteration = Iteration + 1
3
START AT 1
LO <= 108.5+10.7 MHz?
11
N
END
Iteration<= 10?
4
N
Y
Counter > = 8?
8
Check for spurious
N
LO freq = LO freq + 0.1 MHz
10
Y
IF level >= discriminator threshold?
5
Check for signal above discriminator threshold
Station=TRUE STORE RF
9
Y
N
FMIF = 10.7 +/- 0.075 MHz
6
N
AFC x-over detected?
Y
counter = counter + 1
7
Add delay

INTERNATIONAL SEARCH REPORT

Inte: nal Application No
PCT/IB 03/02427

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H03J1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B H03J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 006, no. 147 (E-123), 6 August 1982 (1982-08-06) & JP 57 069924 A (MITSUBISHI ELECTRIC CORP), 30 April 1982 (1982-04-30) abstract	1-4
A	EP 0 430 469 A (FORD WERKE AG ;FORD FRANCE (FR); FORD MOTOR CO (GB)) 5 June 1991 (1991-06-05) cited in the application abstract; figure 3	1-4

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 September 2003	26/09/2003

Name and mailing address of the ISA	Authorized officer
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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte[illegible]onal Application No
PCT/IB 03/02427

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